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Error-Proofing System using Beaglebone Black

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Abstract—*Mistake proofing or Error -proofing is critical to the lean organization for creating and maintaining manufacturing process stability. Among the tools available to the lean practitioner to improve process stability, error proofing is one of the simplest, yet most effective. For the manufacturer, mistake proofing techniques can be applied to the manufacturing process or the product design itself to prevent manufacturing errors. In this research work, we proposed the Beaglebone Black, which is suitable for computer vision or image processing applications due to its hardware and software flexibility. By using Beaglebone black for Error-proofing system with Embedded Linux and OpenCV, we can improve the manufacturing process to the level of Zero Quality Control of Product.*

Keywords*: Beaglebone Black, Camera, Error proofing, Linux*

1. INTRODUCTION

In recent years, international economy caused a major change in approach to quality management system. The companies are focusing on zero quality systems by using error or mistake Proofing systems. Error-proofing refers to implementation of failsafe mechanism to prevent the processes from producing errors or defects. Although this common-sense concept has been around for long time, it was fully populated by name called Poka-yoke, it is Japanese term developed by Shigeo Shingo in Japan. The philosophy behind error-proofing (or) Mistake proofing (or) Poka-Yoke Method is that it is not acceptable to make a very small number of defects, and the only way to achieve this goal is to prevent them from happening in the beginning place. Then we can achieve "Zero Quality System".

Vision is the most advanced of our senses, so it is not surprising that images contribute important role in human perception. This is analogous to machine vision such as shape recognition application which is important field now-a-days. Since 1970's error-proofing system using Machine Vision technique is being used. This technology has evolved the two major accuracies of machine vision system are Camera and Computer processes. Based on the technology, the components have improved in both price and performance. The result is that over 40,000 systems are installed annually in North America alone. While there are different types of Machine vision systems are available most are that capturing the image of a Work piece or assembly and then analyzing image based on the application. Vision system that performs one hundred percent inspection will detect both system and random errors. Vision system can find all Man or Machine product errors.

Mohd et al proposed shape recognition method where circle, square and triangle object in the image was recognized by the developed algorithm [1]. Brunelli et al solved many important computer vision tasks with template matching techniques like object detection, object comparison, depth computation [2]. Dudek et al described the possibility of usage of mistake proofing device and presented the Poka-Yoke method of preventing errors by putting limits on how operation can be performed in order to force the correct completion of the operation [3]. A Poka-Yoke is any idea generation or mechanism development in a total productive management process that helps operator to avoid (yoke) mistakes (Poka) [4]. The exact reconstruction and restoration of perceived image and its properties such as shape, illumination are the severe problem in an image processing field. This problem can be successfully overcome through efficient computer vision algorithm.

Base on the literature survey, the existing error proofing or mistake proofing system has used high cost computer vision system with complex algorithm. The goal of this research paper is to study the feasibility of using a low cost embedded board in computer vision applications like error proofing system. In this work, a similar approach with modern micro controllers and technology together with low cost and flexible BeagleBone black (embedded computer) is proposed.

2. METHODOLOGY

The Fig. 1 explains how the error proofing system can be used by using Beaglebone black

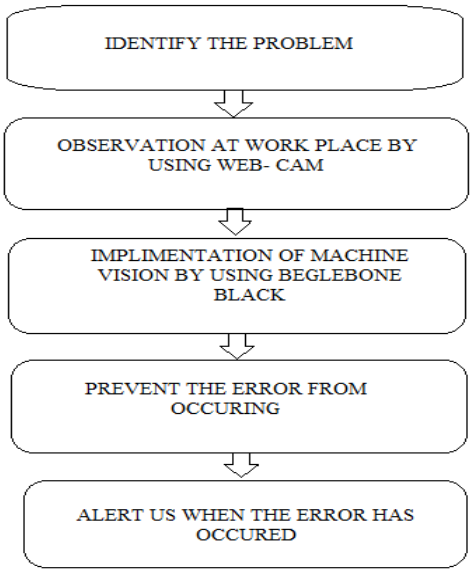

Fig. 1: Methodology

3. SYSTEM DESIGN

In this section, the hardware, software requirement and porting for the entire system design is explained in detail.

3.1 HARDWARE DESIGN OF SYSTEM

3.1.1 BEAGLEBONE BLACK

Fig. 2 shows the Beaglebone black which is a low power open source hardware which is a single board computer produced by Texas instruments. The Beaglebone black is an embedded Linux board based on a 1 GHz Arm Coretx-A8 Processor. It comes with Angstrom Linux Distribution. It is a low cost, community-supported platform for developers. The most interesting features are 4 Universal Asynchronous receivers/Transmitters (UARTs), 8 Pulse Width modulators (PWMs), 65 General-Purpose input/output (GPIO) pins, 2 SPI buses, 2 I2C buses, 1 Analog-to-Digital converter (ADC), and 4 Timers. We will start using GPIO pins for alarm part and output relays with Circuit breakers and many more applications it can be used.

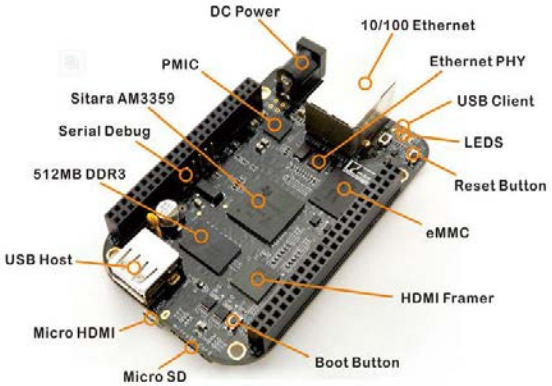

Fig. 2: Beaglebone black

The Beaglebone black configuration is

- Processor: AM335x 1GHz ARM®Cortex™-A8 Processor
- 512MB DDR3 RAM
- 4GB 8-bit eMMC On-board Flash storage
- 3D Graphics accelerator
- NEON floating-point accelerator
- 2 x PRU 32-bit micro controllers

Software Compatibility:

- Angstrom(Linux Distribution)
- Debian
- Android
- Ubentu
- Cloud9 IDE on Node.js w/ Bone Script library.

The Beglebone black needs to set up with Linux operating system so OpenCV needs to be installed. Then a directory must be created to keep the required file codes that are used for computer vision capturing and image processing applications. Once necessary architecture is ready Beglebone black used for computer vision projects.

3.1.2 ARM Cortex-A8 Processer

Fig. 3 shows the ARM Cortex-A8 Processer is highly integrated with robust set peripherals including graphics; connectivity and industrial protocol support, Sitara processors (ARM Cortex-A8 Processer) help innovators create a variety feature-rich, low-power applications. In addition to an extensive selection of silicon, developers have access to a robust software platform for both high-level and real-time operating systems, including support for mainline Linux.

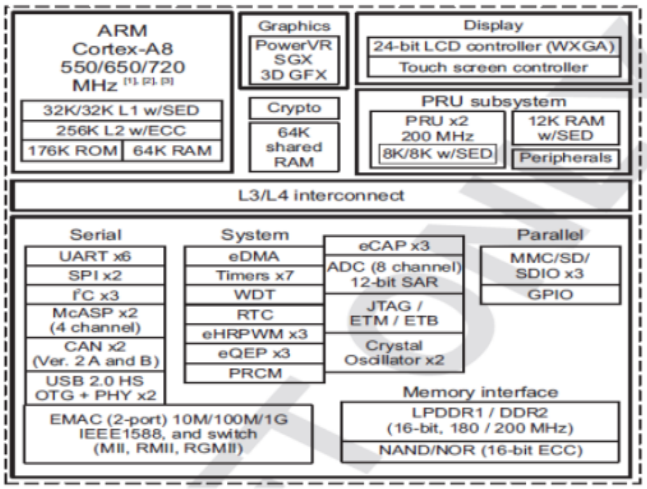

Fig. 3 Block Diagram of ARM processor

3.1.3 USB Camera

USB Cameras are imaging cameras that use USB 2.0 or USB 3.0 technology to transfer image data. USB cameras are designed to easily interface with Computer systems by using the same USB technology that is found on Most of the applications. The accessibility of USB technology in computer systems are 400 Mb/s transfer rate of USB 2.0 makes use many image processing applications. USB cameras are available both CMOS as well as CCD sensor types making them suitable across a larger range of applications.

3.2 Software Requirement

3.2.1 OpenCV

OpenCV is an open source computer vision library. The library is written in C and C++ and runs under Linux, Windows and Mac OS X. There is active development on interfaces for python, Ruby, Mat lab and other languages. OpenCV is designed for computational efficiency and with a strong focus on real time applications. OpenCV is to provide a simple to use computer vision infrastructure that helps people to build fairly sophisticated vision applications quickly. The OpenCV library contains over 500 library functions that uses in many areas in Vision applications. Include factory product inspection and any other error proofing applications.

4. ERROR-PROOFING SYSTEM

Fig. 4 shows the block diagram of error proofing system. The implementation of error-proofing system needs Beaglebone black with OpenCV module. In which the interfacing of USB camera with Beaglebone needs drivers. The error proofing system can be implemented in several ways by using embedded platform the cost of the implementation and maintenance is very less compared to normal error proofing systems.

The OpenCV has the following Modules and functions

- **Core**: Basic Data Structures
- **Imgproc:** image processing, filter, transformation
- **Highgui:** GUI, codes, image/video capturing
- **Calib3d:** Camera calibration,3D reconstruction
- **Feature2d:**2D features (detector, descriptor, matching)
- **Video:** Motion tracking, foreground extraction
- **Objdetect:** Object detection(Face, people)
- **Ml:** Machine learning library

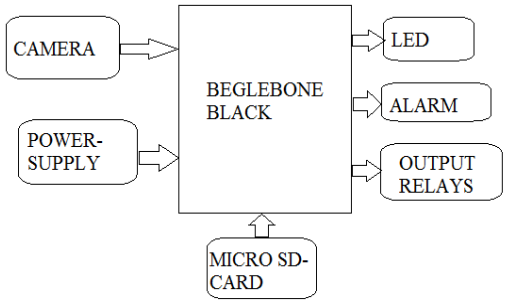

Fig. 4: Block Diagram of Error proofing System

Using any one of the modules, we can develop Error-Proofing system. The camera is used to capturing the image, the image has number of pixel values stored in rows and Column

- **Rows**-Number of rows in the 2D array(height of the image in pixels)
- **Cols**-Number of columns in 2D array (Width of the image in pixels)

The general image processing techniques are done using OpenCV as shown in Fig. 5.

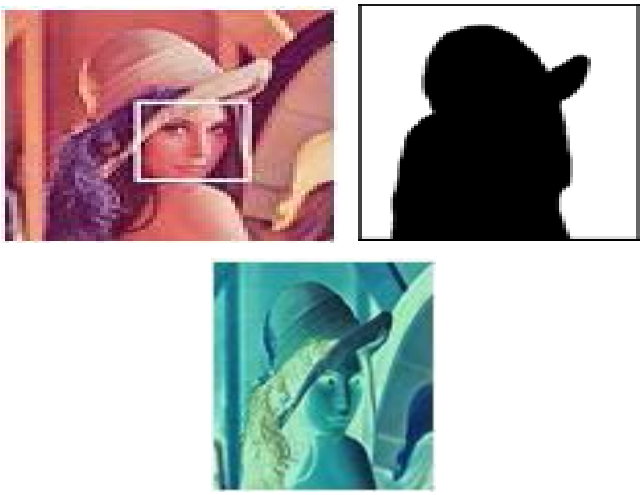

Fig. 5: General image processing techniques

After the Image is processed by OpenCV using Beaglebone black, the GPIO pins are used to give signals like alarm, relay or any other action. The overview of error-proofing system is shown in Fig. 6.

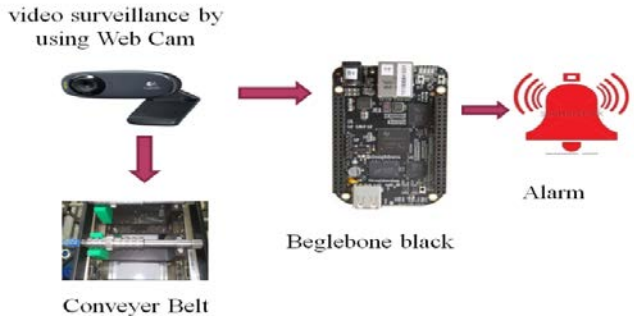

Fig. 6: Overview of error-proofing system

5. CONCLUSION

The low cost error proofing system is developed using Beaglebone black (Embedded computer). The feasibility of using a low cost embedded board in computer vision applications like error proofing system is studied. Based on the developed low cost error proofing system the following conclusions were made,

- The implementation of real time image processing techniques like Edge-detection and Template matching can be done and it can be used to develop a flexible error proofing systems in computer vision applications.
- In low cost, the Beaglebone black having more GPIO pins that can be used to connect more inputs and outputs like alarm, relays and sensors.
- This research can be extended to applications such as Micro air vehicles (MAV) and object tracking systems.
- This approach can be improved further to achieve better product quality and to make low cost error proofing systems.

REFERENCES

[1] Mohd Firdaus Zakaria, Hoo Seng Choon, and Shahrel Azmin Suandi "Object Shape Recognition in Image for Machine Vision Application" International Journal of Computer Theory and Engineering, Vol. 4, No. 1, 76-80. 2012.

[2] R. Brunelli, "Template matching techniques in computer vision: theory and practice," Wiley, ISBN 978-0-470-51706-2, 2009.

[3] M. Dudek-Burlikowska, D. Szewieczek, The Poka-Yoke method as an improving quality tool of operations in the process, Journal of Achievements in Materials and Manufacturing Engineering Vol.36, 95-102, 2009.

[4] Shimbum N. K., Improving Product Quality by Preventing Defects, Productivity Press, Cambridge, Massachusetts 1998.

[5] H. Lachajczyk, M. Dudek-Burlikowska, Quality continuous improvement of company with usage the Poka-Yoke methods, PSKN 7/2006, [57-64], (in Polish).

[6] J. P. Lewis, "Fast Template Matching," in Proc. of Canadian Image Processing and Pattern Recognition Society, Quebec, 120-123, 1995.

[7] Pradeep kumar M and Lokesh H, Real time implementation of Computer vision Algorithms on Beagleboard, IOSR Journal of VLSI and Signal Processing, Vol.4, 1-6, 2014.

[8] www.Beaglebone.org

[9] www.ti.in

[10] www.opencv.org